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EDWARD JENNER, M. D., LL. D., F. R. S., &c.

VARIOLA

AND

VACCINIA.

History and Description.

Hints Relating to the Propagation of Vaccine Virus. Certain Anomalies in the Course of the Vaccine Disease.

WITH ILLUSTRATIONS.

ISSUED BY
THE NEW ENGLAND VACCINE COMPANY,
294 BROADWAY, CHELSEA STATION,
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VARIOLA.

NO definite knowledge of the origin of the destructive plague, small-pox, has been discovered by writers on the subject, but histories and traditions of Eastern nations, especially of China and Hindostan, refer its commencement to a remote period before the Christian era. Most authorities place the date of its appearance in Egypt about A. D. 544, although it is believed by some writers that Philo, a Jewish philosopher, mentioned it in a work on the Life of Moses, written in the first century. It spread into Asia and Africa during the sixth and seventh centuries, and into the countries of Europe in the ninth and tenth centuries. The Spaniards carried it into Cuba and San Domingo soon after the discovery of America. It raged in Mexico in 1527, its victims numbering millions. From that date it gradually extended over the whole American continent.

The first accurate and scientific description of the disease came from Rhazes, a celebrated Arabian physician, A. D. 925–926. Records of historians and travellers from the earliest ages teem with dismal details of the destruction of human life by this contagion. Its awful visitations seem to have been common throughout the world.

The annual mortality from small-pox in England is said to have averaged about three thousand to each million of inhabitants.

In France thirty thousand victims perished each year.

In the Russian Empire it is reported to have been so malignant as to have cut off two millions of inhabitants in a single year.

During the years from 1783 to 1799, inclusive, one-tenth of the entire death-rate of Berlin was from this disease alone.

Dr. Lettsom, of London, calculated that in Europe, annually, two hundred and ten thousand beings were by this means deprived of life.

In Ceylon its appearance caused whole villages to be abandoned.

More than one hundred thousand Indians were destroyed by it in one year in the province of Quito, South America.

It was no respecter of persons. Kingdoms and empires were thrown into confusion by the death of crowned heads. Among its royal victims history mentions five descendants of Charles I., of Great Britain, viz.: Henry, Duke of Gloucester; Mary, wife of the Prince of Orange and mother of William III.; Charles, Duke of Cambridge, in 1677; Mary, Queen of England and wife of William III., in 1694; and the Princess Mary Louisa in 1712. Also five descendants of Louis XIV., of France, and in the same period Joseph I., Emperor of Germany, in 1711; Peter II., Emperor of Russia, in 1730; a queen of Sweden in 1741; Henry, Prince of Prussia, 1767; Maximilian Joseph, Elector of Bavaria, in 1777.

Macaulay, the English historian, did not exaggerate when he called the disease "the most terrible of all the ministers of death," and said, in describing its ravages in the seventeenth century, "Small-pox was always present, filling the churchyard with corpses, leaving on those whose lives it spared the hideous traces of its power," for two-thirds of the pauper blind in England were made so by this cause.

Dr. Cyrus Edson, Chief Inspector of Contagious Diseases, New York Health Department, in his Annual Report of 1890, says: "Small-pox is fatal to a very large proportion of those whom it attacks. It kills from thirty to forty per cent. of its victims. It has been described with great accuracy by very early writers; nevertheless, its history previous to the seventeenth century is obscure, and must be regarded as defective on account of its having been confounded with measles and other forms of eruptive disease.

"During the seventeenth and eighteenth centuries not a decade passed without an occurrence of fearful epidemics of small-pox. In England from seven to nine per cent. of all the deaths were due to it. It was one of the most destructive diseases, attacking, as it did, persons in every station in life.

"During the sixteenth century, in Mexico, 3,500,000 persons died of small-pox. In 1734 nearly two-thirds of the population of Greenland were swept away by an epidemic of the disease; and in Iceland 18,000 persons died out of a population of 50,000.

"Its ravages among savage nations are not less disastrous than among the civilized. Whole tribes have been exterminated. Washington Irving and other writers have graphically described the horrors it wrought among our North American Indians.

"One of the most vivid pen-pictures of the devastation wrought by small-pox before the introduction of vaccination is given by Professor Wernher, in his work entitled 'Zur Impffrage.' It is as follows

"'Before the introduction of vaccination small-pox had become a permanent disease which never entirely ceased

in any one year, and every three or five years became a great epidemic.

"'In non-epidemic years one-tenth of all mortality was from variola; in epidemic years, one-half.

"'Very few men escaped small-pox till old age; almost every one sickened at least once in his life of this horrible, murderous disease.

"'Countless mortals were maimed by loss of sight. Of new-born children one-third died of small-pox before their first year; one-half before their fifth year of life.

"'There was no family which had not heavy losses to deplore.

"'In the country the mortality was greater than it was in the city.

"'Physicians and government possessed no means against this abominable evil. Isolation was impracticable, from the wide-spread nature of the disease. Men accepted the pest as an unavoidable fate.

"'The loss which Europe suffered from this one disease amounted to many millions. It was the principal factor which deterred or kept back the population from progress; and to lead us back to these conditions are the efforts of many ignorant mortals directed.'

"Comparing the present conditions with those just stated, the author goes on to say:

"'We now find no child mortality among vaccinated children. Also among adults, whenever vaccination and revaccination are maintained, mortality from small-pox is at an end.'

"The following table is compiled from the 'Report of the Epidemological Society of London,' and shows the

mortality from small-pox during periods before and after the introduction of vaccination. The periods are not in each case the same, but they are those of which it was possible to obtain reliable information.

APPROXIMATE AVERAGE ANNUAL DEATH-RATE BY SMALL-POX PER MILLION.

Period Relative to which Data are Given.	Country or City.	Before Vaccination.	After Vaccination.
1777-1806 and 1807-1850.	Lower Austria,	2,484	340
1776-1780 and 1810-1850.	Prussia, Eastern,	3,321	56
1780 and 1810-1850.	Prussia, Western,	2,272	356
1781-1805 and 1810-1850.	Berlin,	3,422	176
1774-1801 and 1810-1850.	Sweden,	2,050	158

"In the table, of which the foregoing is a part, twenty-one other cities or States are given, each of which shows the same remarkable reduction. I would call your attention particularly to Berlin. The death-rate from small-pox there was 3,422 per million living inhabitants during the twenty-four years before the introduction of vaccination, and 176 per million in the forty years after that time.

"In the city of New York the following table, compiled from the yearly records of the Health Department, shows the death-rate from small-pox from 1869 to 1888, inclusive:

DEATHS FROM SMALL-POX.

YEAR.	DEATHS.	POPULATION.	RATE PER 100,000.	YEAR.	DEATHS.	POPULATION.	RATE PER 100,000.
1869	203	927,728	21.90	1880	31	1,206,299	2.57
1870	805	942,292	31.08	1881	453	1,242,533	33.30
1871	805	954,636	84.32	1882	259	1,279,560	20.34
1872	929	967,142	96.16	1883	12	1,317,691	0.91
1873	117	979,811	11.94	1884	0	1,356,958	0.00
1874	484	992,646	48.75	1885	26	1,397,395	1.86
1875	1,280	1,041,886	122.85	1886	31	1,439,037	2.15
1876	315	1,072,934	29.36	1887	99	1,481,920	6.58
1877	14	1,104,907	1.27	1888	81	1,526,081	5.31
1878	2	1,137,833	0.18	1889	1	———	——
1879	25	1,171,740	2.13	1890	0	———	——

"The results of the work of the Vaccination Corps did not become apparent until 1876.

"The death-rate from small-pox previous to 1876 was 59.57 per 100,000. Since that year it has been only 8.38 per 100,000.

"In Paris, where vaccination is not energetically enforced, the death-rate from small-pox ranges from 136 to 10.1 per 100,000 inhabitants.

"In the principal German cities, where vaccination laws are enforced with rigor, the death-rate from small-pox is 1.44 per 100,000 inhabitants.

"In London, where compulsory vaccination is rigidly enforced, the death-rate from small-pox is only 0.6 per 100,000.

"In the Canton of Zurich, Switzerland, since the compulsory vaccination law was repealed, the mortality from small-pox has risen from 8 to 85 per 100,000 inhabitants.

"When small-pox prevails in a community where some

are protected by vaccination and others are not, the influence of vaccination is strikingly exhibited.

"In observations shown for twenty-one years on 4,000,000 people in Bohemia, it was discovered that the death-rate among vaccinated persons, in whom the protected power had diminished by reason of age, was 5 1-16 per cent., while among those who had never been vaccinated it was 29 4-5 per cent. Illustrations of this kind could be multiplied, as almost countless authentic statistics exist.

"In New York the first question asked by the Inspector of Contagious Diseases of a person sick with a doubtful case of small-pox is, 'When were you successfully vaccinated?' And if the answer indicates it was done a period of five or six years before, the disease is believed not to be small-pox.

"During over nine years of service in the Health Department of New York I have never seen a case of small-pox in a person who had been vaccinated successfully within five years, and the number of cases I have seen mount into hundreds.

"During that period, I have seen only one Inspector of Contagious Diseases contract small-pox, and he was the only Inspector who disbelieved in vaccination, and refused to have it performed on himself."

INOCULATED VARIOLA.

From a very early period in the history of small-pox, inoculation had been extensively performed in Eastern countries, particularly in China, India and Turkey, and in 1722 the practice was adopted in England and America.

To mitigate the loss of life and contagious effects of a

disease so generally feared because of its malignity, many individuals, in the hope of gaining security against future attacks, submitted to inoculation, which produced the malady in a less severe form.

The virus from small-pox was introduced into the circulation through the skin, this process resulting in a comparatively mild form of the disease. It proved to be a benefit to those inoculated, but a constant source of contagion was established. Small-pox propagated in this manner conveyed infection to such an extent that the general mortality was greater than before the practice was known.

In 1840 an Act of Parliament was passed, rendering small-pox inoculation unlawful in England.

In many of the older towns in New England, the ruins of hospitals, for the isolation and inoculation of small-pox can be seen to-day.

MEASLES.

Among the eruptive diseases most similar in their early stages to variola, the correct differential diagnosis of which has often puzzled men of experience, may be mentioned measles, varicella, and, in rare cases, the papular form of secondary syphilis. This last, however, is of so infrequent appearance and is attended with so slight general fever that little need be said of it.

In measles, each erythematous patch will be found to cover a larger area than variola. A case of variola with erythema as extensive as is seen in measles would be attended with a temperature as high as 104 or 105, with pulse correspondingly high, while in measles the tempera-

ture seldom rises above 101 or 102. In measles the catarrhal symptoms, sneezing, increased lachrymal secretions, suffused conjunctivæ, and an obstinate cough, precede the eruption, or appear at the same time. So important a symptom is the cough, that it is often said that an eruption having the appearance of measles should not be diagnosed as that disease if the cough is not present. In variola this symptom is usually absent, or may appear at a later stage of the disease. In measles the eruption pales and begins to fade on the second or third day. In variola it becomes intensified, with a slowly forming vesicle in its centre.

VARIOLA AND VARICELLA.

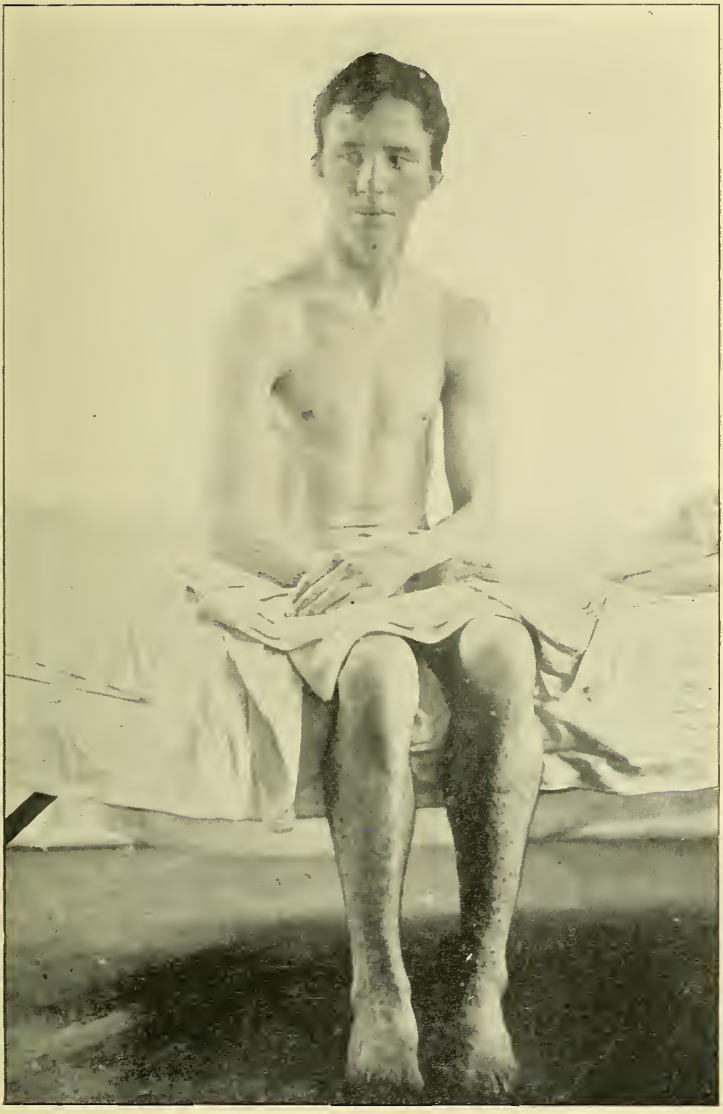
The following extract from the writings of Dr. John D. Fisher, of Boston, gives an admirable comparative description of the two diseases.

"In most cases the chicken-pox is, by the experienced observer, easily and readily distinguished from the small-pox. When, however, the former is extraordinarily violent, and the latter unusually mild, the distinguishing marks are obscure, and the two diseases are therefore frequently confounded. To render the distinctions as clear as possible, the more prominent symptoms of the two diseases are here contrasted with each other.

"In *small-pox* the fever is ushered in by a cold stage, is severe and continues three or four days, and if it declines or ceases during the eruptive process, it commonly reappears during the suppurative stage, or between the fifth and eighth day of the eruption.

"In *chicken-pox* the fever is not often preceded by a cold

VARICELLA.
Third Day of the Eruption.



VARIOLA.
Third Day of the Eruption.

stage, is uniformly light and is frequently insensible; it seldom continues more than two days and never reappears after it has once ceased. When, however, the vesicles appear in successive crops the fever lasts longer and rages until the eruption is completed.

"In *small-pox* the eruption is often preceded or accompanied by an erysipelatous efflorescence.

"In *chicken-pox* this efflorescence does not take place.

"In *small-pox* the eruption does not break out until the third or fourth day of the fever; it appears first on the face, then on the neck, chest, trunk and extremities, and is completed in the course of two days.

"In *chicken-pox* the eruption breaks out by the termination of the first or on the second, and almost invariably before the end of the third day of the fever; it usually appears first about the breast and shoulders, afterwards on the face and extremities. It often, however, follows a different order, and is never so uniform in the method of its invasion as the eruption of the small-pox; it frequently appears in successive crops for four or five days.

"In *small-pox* the eruption presents itself in the form of small red circular points or papulæ; these are hard, resisting and movable, and communicate to the finger a shot-like sensation. They scarcely project above the surface, but are easily and distinctly felt by drawing the finger over them.

"In *chicken-pox* the eruption likewise breaks out in small inflamed spots, but these are not papular in their origin, and are not exactly circular, but tend to an oblong figure. They may be distinctly felt by the finger, but they are yielding under it and are destitute of the tuber-

VARIOLA.
Fourth Day of the Eruption.

cular hardness and rolling motion which characterize the variolous eruption at the same period.

"In *small-pox* the eruption seldom becomes vesicular before the end of the second or the commencement of the third day, and the vesicles are confined to the summits of the pocks.

"In *chicken-pox* the eruption is vesicular from the beginning, or from the early part of the first day, and by the second day the whole surface of the pocks are converted into vesicles which resemble little bladders of transparent fluid.

"In *small-pox* the pustules at first have acuminated summits; they afterwards become rounded, and at an early period present slight depressions in the centre of their surfaces.

"In *chicken-pox* the vesicles are usually lenticular in form, but are sometimes conoidal or globate, and preserve one shape through their course, or until they become ruptured.

"In *small-pox* the eruption is situated in the substance of the cutis, as has been proved by dissection, and as is evident from the sensation which the pustules communicate to the finger.

"In *chicken-pox* the vesicles are not formed in the true skin, but are situated upon its surface in the cellular tissue between the skin and cutis.

"In *small-pox* the pustules after they have become vesicular are distinguished by hard, unyielding bases.

"In *chicken-pox* the vesicles are destitute of such tubercular bases. They are yielding and easily give way under pressure, and communicate to the finger a soft, elastic sensation, or a feeling similar to that which a

VARIOLA.
Fifth Day of the Eruption.

minute globule of fine sponge softened with water would give rise to when pressed.

"In *small-pox* the pustules are composed of little cells, all of which, however, communicate with each other; and the cuticular coverings of the pocks are opaque, tough and not easily broken.

"In *chicken-pox* the vesicles are composed of a single cavity, and the coverings are extremely thin and fragile, are diaphanous and are very easily broken.

"In *small-pox* the pustules are, at an early stage, filled with a serous secretion; this after a time becomes converted into a purulent matter that exhales a very unpleasant and peculiar odor.

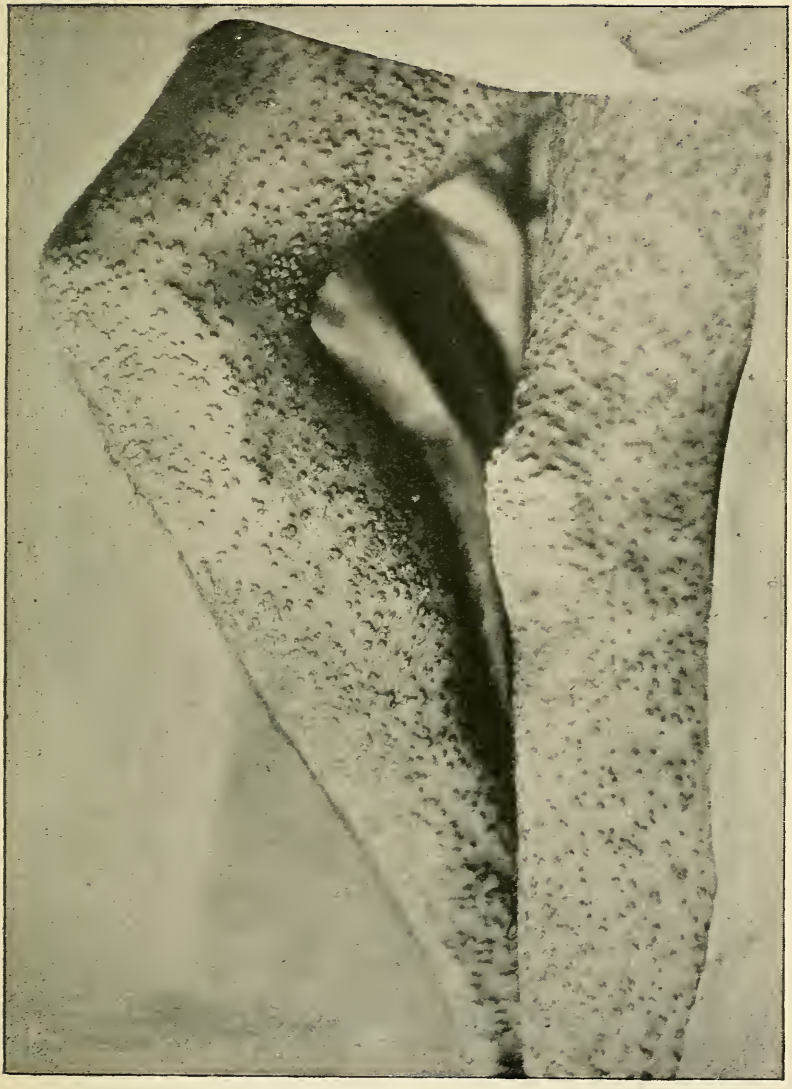
"In *chicken-pox* the vesicles contain, when fully matured, only a whitish, transparent and serous fluid; this never, except through accident, becomes pus, and is destitute of any ungrateful odor.

"In *small-pox* the pustules remain whole till they are six or seven days old, when some of them commonly become ruptured, and permit a little of the virus to ooze out upon their surface; but they still retain their form and prominency.

"In *chicken-pox* the vesicles often become broken in two or three days after their appearance, and permit the whole of their contents to escape. Their coverings then sink down and collapse, and the vesicles become flattened and lose their original form.

"In *small-pox* the pustules break out simultaneously, pursue a regular march and arrive at maturity at about the same time.

"In *chicken-pox* the vesicles generally break out in successive crops for a number of days, in which case a



VARIOLA.
Sixth Day of the Eruption.

great variety may be observed among them; some are appearing, whilst others are fully formed, shrivelled or crusted.

"In *small-pox* desiccation does not commence till about the eighth day from the appearance of the eruption.

"In *chicken-pox* when the vesicles run their course without bursting, desiccation commences in them as early as the fifth day of their age, but it always begins as soon as the vesicles are ruptured, and consequently it more usually commences on the third or fourth day, and sometimes as early as the second day after they appear.

"In *small-pox* the processes of eruption, of suppuration and of desiccation constitute three successive periods, rendered distinct from each other by their duration; the first occupies about three days and the other two about five days each.

"In *chicken-pox* these three periods seem to be confounded in consequence of the pocks appearing in successive crops, and even when they are distinguishable, the sum of their duration seldom exceeds eight days.

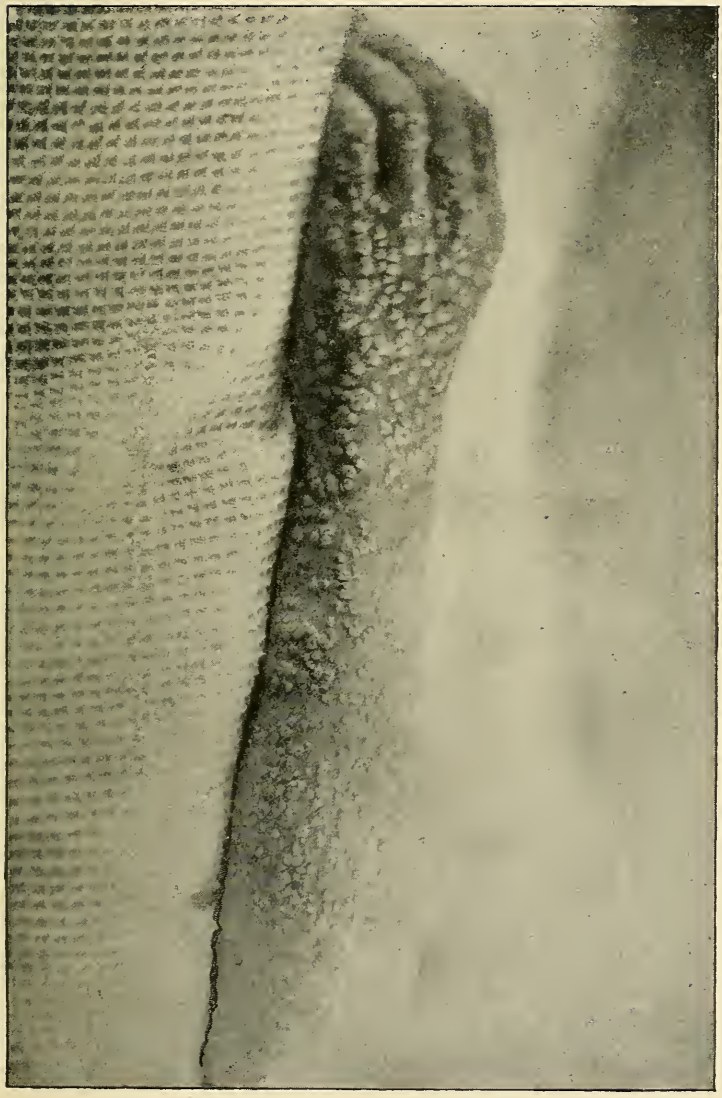
"In *small-pox* the scabs fall off in a single piece.

"In *chicken-pox* the scabs do not usually fall off in a single piece, but in small fragments of different forms and sizes.

"The *small-pox* even when distinct and of moderate mildness, is a disease of fifteen or twenty days in duration, and it often proves fatal.

"The *chicken-pox*, on the contrary, runs its course and is completed in five or six days, or in eight or ten at most, and it never, of itself, proves fatal.

"The distinctions between the chicken-pox and the varioloid disease, or the small-pox in its modified form, are



VARIOLA.
Seventh Day of the Eruption.

less striking, and less easily recognized. The following peculiarities, however, may generally be observed in the two diseases, and will, in most cases, lead to a correct discrimination.

"The *chicken-pox*, as has already been stated, is distinguished by the eruptive fever being generally light.

"In the *varioloid disease* the precursory fever is commonly sharp and of several days' duration.

"In *chicken-pox* the eruption appears in the form of vesicles, or it is vesicular, at least, from an early period of the first day.

"In the *varioloid disease* the eruption is always papular in its origin, and seldom becomes vesicular before the second or third day. It appears all at once and seldom breaks out in successive crops. The pocks are, in the first instance, elevated on solid tubercular bases, and their tops are resisting and not easily broken. The eruption, as in the unmodified variola, is formed in the substance of the true skin, as is evident from the hard and elevated bases which remain after the lymph is removed from the pustules by puncture and pressure, and by the kernels or tubercular elevations which remain in the skin after the scabs have fallen off. The pocks from their first formation are hard and unyielding, and are movable and rolling under the finger.

"To these distinguishing characteristics, all of which have been noticed by various writers, the author would add the following:

"In *chicken-pox*, if, during the first day of the eruption, the parts on which it exists be embraced with the thumb and finger and gently distended by them; or if a single finger be drawn over them with a force just sufficient to

VARIOLA.
Eighth Day of the Eruption.

cause the little rugæ of the cuticle to become smooth, the inflamed spots, in which form the vesicles first present themselves, readily disappear and leave no discoloration or induration in the skin.

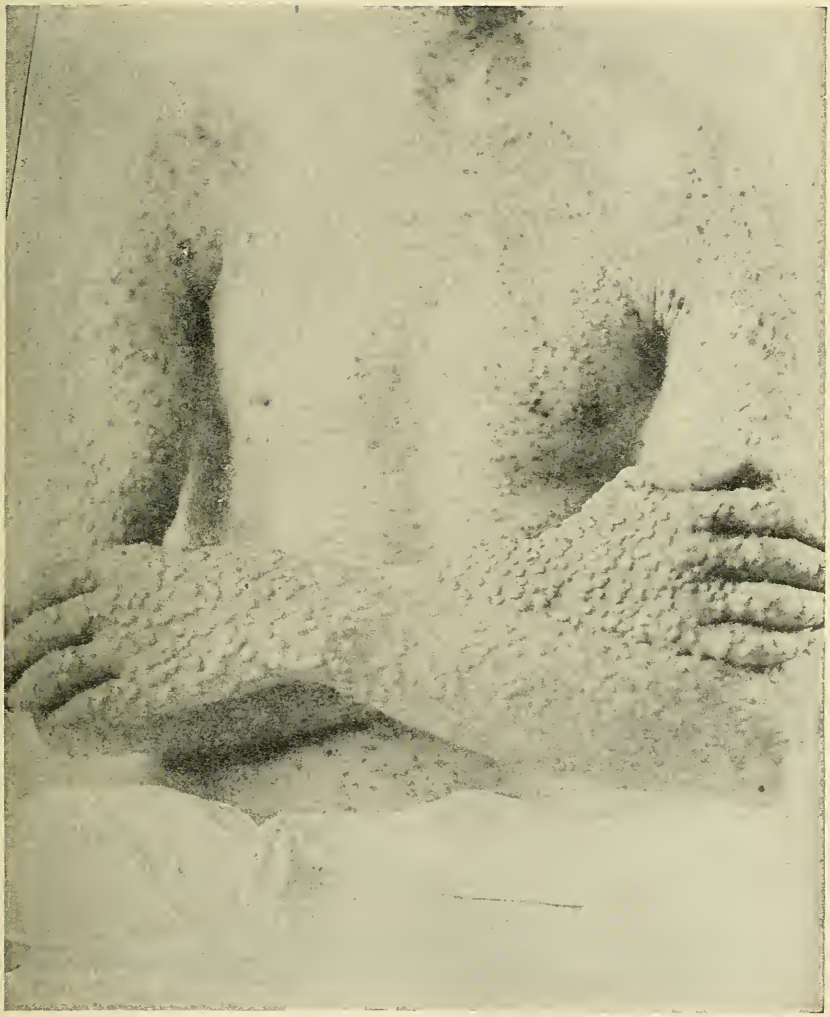
"In the *varioloid disease*, if a like distention of the parts occupied by the eruption be made at the same date, the inflamed spots disappear less readily and, even when the distending force is sufficiently great to make them disappear, a dim discoloration can be perceived and a distinct shot-like hardness may be felt at the points upon which they were planted.

"In *chicken-pox* the scars left in the skin after desquamation are destitute of any peculiar hardness, and are, in the space of a few days, entirely erased.

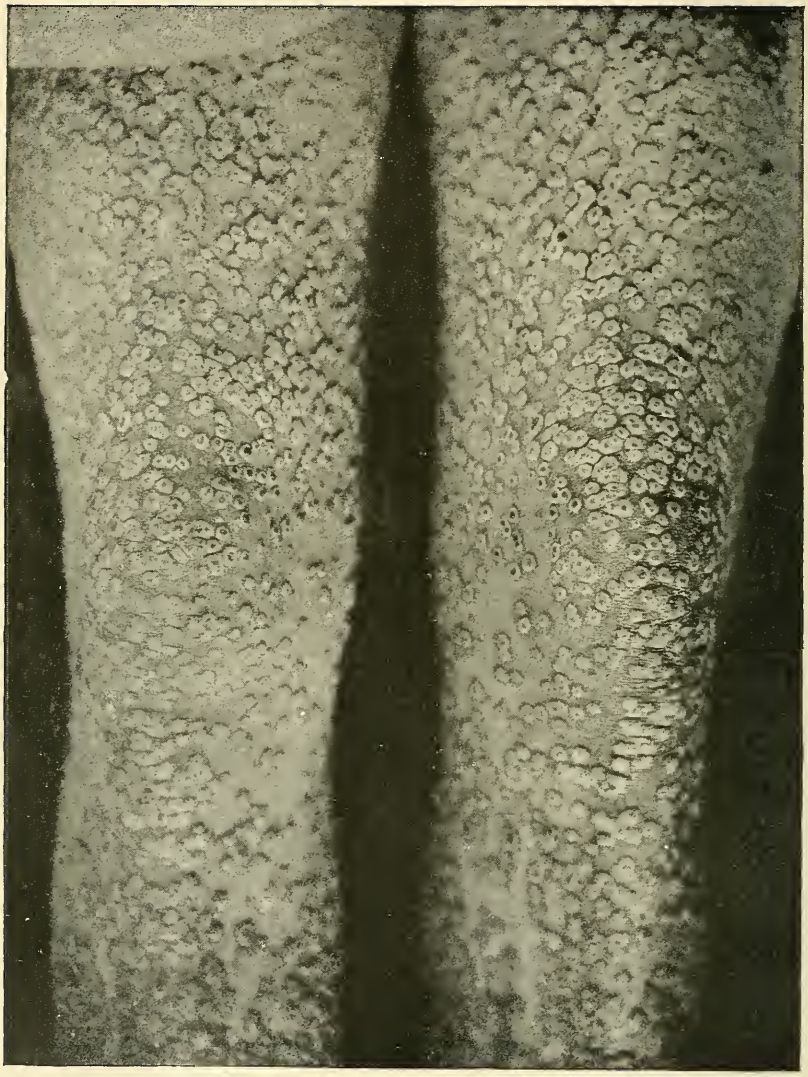
"In the *varioloid disease* the eruption, for a considerable time after the scabs have fallen, leaves little kernels, or tubercular elevations, in the skin. The varioloid disease has the power of communicating the unmodified and modified small-pox."

In addition to a careful study of these distinguishing features, the physician should ascertain if the patient has been successfully vaccinated within five years; if so, the probability is in favor of varicella, particularly if the subject is a child, as varicella rarely affects an adult.

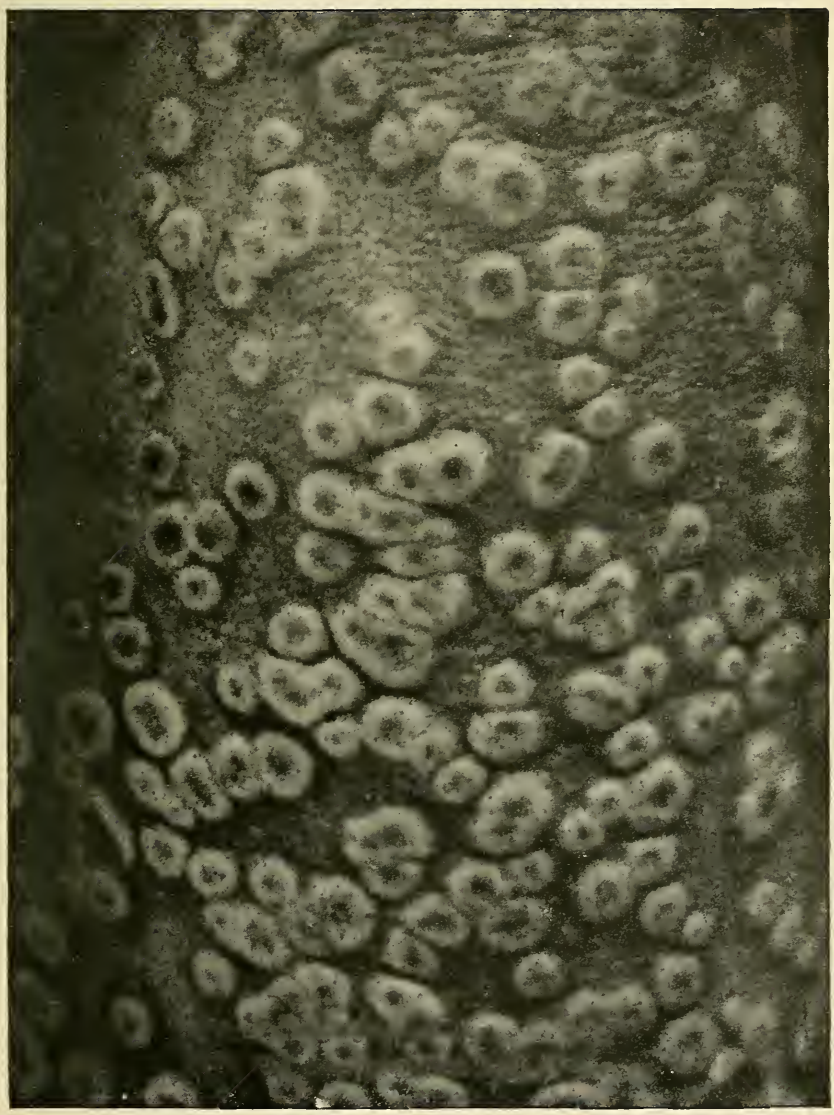
As an aid to the physician in making his diagnosis of variola, the photographs shown may be valuable, as they are the only known photographs of this disease in existence.



VARIOLA.
Tenth Day of the Eruption.



VARIOLA.
Eleventh Day of the Eruption.



VARIOLA.
Eleventh Day of the Eruption.
Actual size of the pustules.

VACCINIA.

In 1798, Edward Jenner, M. D., F. R. S., a surgical practitioner of Berkeley, Gloucestershire, England, in a pamphlet entitled "An Inquiry into the Causes and Effects of the Variolas Vaccinæ," made known to the world the discoveries, investigations and experiments which he had been conducting for twenty years, in the hope of proving theories the successful practice of which would secure immunity from this pestilence without endangering life. He had observed that the dairy folk in that section of the country were generally exempt from small-pox, and, from the casual remarks of a milker, had learned that this was supposed to be due to the fact that many of them had accidentally contracted cow-pox from "sores on the cows' teats," and, in this way, became insusceptible to the contagion of small-pox. Experiments proved the correctness of this theory, for in two years Jenner inoculated over six thousand subjects with the virus of cow-pox, and those persons were afterward exposed to small-pox without effect.

Vaccinia, or cow-pox, is a specific eruptive disease which occurs as the result of transmission among young cows and milch heifers. It was by no means uncommon, and after attention was called to it by Jenner, the disease was known to have existed in at least eighteen counties in England. There are recorded discoveries of cow-pox in the cow in other European countries, and in South America, Asia and Russia. In 1809 it was said to have been observed by physicians in Massachusetts and Connecticut. In many cases, stocks were raised from these and passed more or less into general use, but in America the Jennerian stock was all that could be depended upon.

Dr. Samuel A. Green, the able historian of the Massachusetts Medical Society, in his centennial address, has given the following valuable information in regard to the early history of vaccination in this country. "The protective power of vaccination was discovered in England by Edward Jenner, near the end of the last century, and the news of its discovery was soon brought to this country. Among the first persons here, and perhaps the first, whose critical attention was called to its importance, was Dr. Benjamin Waterhouse, of Cambridge, an early Fellow of this Society. Its introduction, like that of variolous inoculation, was destined to meet with many difficulties and obstacles, and Dr. Waterhouse was to be the champion. He wrote much as an advocate of the cause, and, against popular ridicule and prejudice, he succeeded in carrying the day. A communication, signed with his initials and dated at Cambridge, March 12, is found in the *Columbian Centinel* of March 16, 1799. It is headed, 'Something Curious in the Medical Line,' and is the first account of vaccination that was given to the public in this country.

"He printed the account in a newspaper in order to excite 'the attention of our dairy farmers to such a distemper among their cows,' and to inform the profession generally of this security against small-pox. Massachusetts was the first colony to introduce small-pox inoculation, and she was also the first State to adopt kine-pox vaccination. During the summer and autumn of 1802, some interesting experiments were conducted under the direction of the Boston Board of Health, whose unremitting exertions at that time, to prevent contagious diseases, entitle them to the highest praise. The Board fitted up a hospital on Noddle's Island, now known as East Boston, and invited a

number of physicians to co-operate with them in an undertaking to diffuse knowledge and dispel prejudice in regard to vaccination.

Some bold experiments were tried at this hospital, and fortunately all were successful. On August 16, nineteen boys were vaccinated, and all passed through the regular stages of the cow-pox; and on November 9th, twelve of these children, together with the son of Dr. Bartlett, who had previously had the cow-pox, were inoculated for the small-pox, with matter taken from a patient in the most infectious state of the disease, and no trouble whatever followed. They had, moreover, been exposed to infection, most of them for twenty days, by being in the same room with the two lads who had the small-pox; and all nineteen escaped. These and other facts are given in a report which was made and signed by eleven physicians, James Lloyd and Benjamin Waterhouse appearing at the head of the list. A full and official account of the whole affair is found in the *Columbian Centinel*, Dec. 18, 1802."

Vaccination, as originally practised by Jenner, was performed with the cow-pox lymph direct from the animal on a few selected cases only, the humanized vaccine virus so produced being subsequently transmitted from one person to another, through many generations. In this arm-to-arm vaccination, the lymph probably passed through millions of human systems, and very naturally the efficacy decreased, owing to its continued use for over seventy years.

The marked increase in mortality from small-pox among the vaccinated seemed to indicate that repeated human transmissions had so deteriorated the old Jennerian stock as to render it of little value as a prophylactic. The

consequences might have been disastrous to the cause, had not new cases of vaccinia been opportunely discovered.

In April, 1866, a case of cow-pox occurred in Beaugency, France, which, by transmission through successive heifers, was perpetuated by the French government, with the aid of the French Academy of Medicine. Four years later, in 1870, this stock was brought to America by Dr. Henry A. Martin, of Boston.

Among dairy herds in this country, the development of an occasional case of vaccinia is not rare at the present time and has not been for the last fifteen or twenty years. The prevalence of this disease has become more noticeable in later years on account of infection from the mature heifers and milch cows frequently vaccinated by propagators. There is great difficulty in preventing the spreading of cow-pox among unvaccinated animals that come in contact with the vaccinated. Were it not for the most scrupulous care on the part of the vaccinators, a large proportion of animals would leave the operating rooms with well-developed pustules upon their udders, thus furnishing a ready means of infecting, through the medium of the milkers' hands, the various herds among which they may be distributed.

Many propagators have announced the discovery of entirely new stocks of lymph purporting to be from spontaneous cases. The spontaneous nature of cow-pox is doubted by the best observers and writers of the present day, therefore, it remains an open question whether all these so-called spontaneous cases did not originate from infected animals sent out from the operating rooms of propagators. Taking this view of the subject, it becomes evident that the only existing stock of lymph now in use

in this country is, by hereditary descent, still the Beaugency, which was imported in 1870. Suffice it to say, experience in all recent epidemics of small-pox has proved the efficacy of this stock as a prophylactic, as no case of variola following a recent vaccination or re-vaccination has been reported for several years.

The discoveries of Jenner, his experiments, the use of the so-called Jennerian lymph for a period of nearly seventy years, the development of the Beaugency stock and its important service in the epidemics of the past twenty-seven years, are familiar to all practitioners of medicine.

That vaccination is the only preventive of small-pox, very few at this time doubt.

That small-pox may, as an exception to the rule, attack a well vaccinated person, all must admit; for it is a matter of medical history, often repeated, that small-pox may attack a person twice and sometimes thrice. Many eminent observers, before and since the discovery of vaccination, have noted recurrent cases of small-pox. Jenner alludes to the death of Louis XV. from a second attack of the disease.

An interesting case was observed in the small-pox hospital in Boston in 1875. A patient, who, while convalescing, was temporarily filling the position of nurse, became a victim a second time, and proceeded regularly through the disease, all the stages being just as severe as at first. On recovering, he was again exposed, and contracted the disease, making a series of three attacks in the course of eight months.

A similar case is noted as having occurred in a small-pox hospital in San Francisco in 1876.

These, and many other cases, lead to the conclusion that small-pox occurs after vaccination no more frequently than the disease is repeated in the same individual. It should be remembered, however, that at the present time the opportunities for observing instances of small-pox following vaccination are greater, for the reason that a large proportion of the population have been vaccinated, while but a limited number have had small-pox.

There exists in the system of all persons, to a greater or less degree, an undefined element-principle, which may be called pabulum, upon which the disease germ of small-pox subsists. All the protection known to science consists in the destruction and elimination of this pabulum. The vaccine germ, as well as the germ of variola, subsists upon this and consumes it. It is evident that in many persons pabulum is slowly reproduced, in others, rapidly. The primary, infantile vaccination of some individuals continues to protect them through life. This seems peculiar to whole families, while others respond, in some degree, to vaccinia or variola, as frequently as once in ten years. Such persons should be vaccinated at least every five years.

GROWTH OF THE VACCINE VESICLE.

In primary vaccinations, running a normal course, a slight papular elevation will be observed about the third day after the insertion of the vaccine lymph. In exceptional cases it may be seen on the evening of the second day. On the fourth or fifth, and, in rare cases, the sixth day, it becomes a distinct vesicle of a pearly color, with edges a little elevated, and by the eighth day it has

attained its height and is filled with clear lymph, its elevated margin and depressed centre being more marked. About this time the commencement of umbilication, due to the drying of the lymph contained in the central cells, is observed. The areola, or pink circle around the vesicle, begins to be more prominent and continues to extend for two or three days, being attended by more or less induration and swelling of the axillary glands. When the areola is at its height, the constitutional symptoms, fever, headache and backache, are more or less severe. After the tenth day, the areola begins to fade, and by the fourteenth, a hard, brown scab has formed, which, if left to mature, falls from the twentieth to the twenty-seventh day, leaving, in many cases, a depressed, foveolated scar, having small pits, or apparent pin-holes, in its centre. The pitted scar does not always exist. The areola and constitutional symptoms are the only sure conditions warranting a favorable decision. This is the usual course of a normal vaccination. Should, however, the action of the lymph be delayed even until the eighth day, before any sign of vesication takes place, and then go regularly through its course, it does not change the protective nature of the vaccination. Many deviations from the normal course of the vaccine disease may occur.

It is well to note that secondary vaccinations seldom run a uniform course of development. The stages are usually of shorter duration. Local irritation often commences within twenty-four hours after the initial operation, the subject feels ill at this early date, and by the fifth day the topical inflammation and constitutional symptoms have entirely disappeared. The same variation will be noticed in varioloid, as distinguished from variola, the former

running through its entire course, to the falling of the crusts, in half the time required for the latter.

It is not unusual for the areola accompanying a vaccination to extend far below the elbow and even to the wrist, giving rise to the often reported instances of erysipelas. Many of the older vaccinators called this erysipelas, but according to later observations, the constitutional symptoms of that disease, such as rigors, rapid pulse and high temperature, are not found present. Therefore, the conclusion that the case is simply intensified areola and nothing more should be formed.

True erysipelas will, in a certain very small proportion of cases, follow vaccination, regardless of the purity of the lymph used, or the care the surgeon may have taken in applying it. The history of vaccination has always furnished reports of such cases. If this complication arises within twenty-four hours from the time the lymph is inserted, it may reasonably be attributed to septic germs introduced into the circulation with the lymph; if later in the course of development, it must be attributed to atmospheric germs entering after the vaccination.

Vaccine roseola and lichen are so often seen in the practice of all physicians that it is unnecessary to describe them.

Vaccine exanthema, or general eruption, is either erythematous, lichenoid, or vesicular in form, and is recognized by all experienced vaccinators, but it has often puzzled young physicians, and caused apprehensions of approaching variola, blood-poisoning, or other frightful results of the use of vaccine virus, described in newspapers by the opponents of vaccination.

These erythematous eruptions, which are likely to

VACCINE ROSEOLA.

Appearing on the ninth, tenth or eleventh day after vaccination.

VACCINE ERYTHEMA OR DISTRIBUTED AREOLA.

Appearing on the eleventh day after vaccination and disappearing on the thirteenth.

appear on, or about, the ninth, tenth, or eleventh day, and continue from two to three days, may be called distributed areolæ, and should be classed with the general constitutional symptoms of the vaccine disease. When the areola is extensive and at its height, it becomes, by reason of its intensity, diffused or distributed over a portion of the cutaneous surface, or over the entire body. This erythema always subsides gradually, together with the local areola. It may attend the normal course of the vaccine disease.

Another apparent deviation in the course of the vaccine vesicle is often seen in cases of intense inflammation, resulting in ulceration, many times indolent and slow in healing.

This condition is, no doubt, governed largely by the extent of the cutaneous surface upon which the vaccine lymph is applied. An extended, broad pustule is always attended with more or less topical inflammation, which, in many cases, leads to sloughing. When the lymph used is plentifully supplied with vaccine germs, in other words, when it is very active, it will invariably produce a confluent vesicle, which may naturally be attended with intense inflammation and increased local temperature, sometimes resulting in a destruction of the surrounding tissues. The same condition follows, in many cases, a confluent patch of variolous eruption. It readily yields to mild, stimulating, local treatment, with due attention to cleanliness.

It is the large, confluent vesicle which always leaves a large, deep, shining scar, with none of the characteristic indentations or pits so commonly mentioned as proof of a perfect cicatrix. It is not conclusive that the smooth, deep, shining scar may not, and does not frequently exist after a good and protective vaccination. The vaccinator would

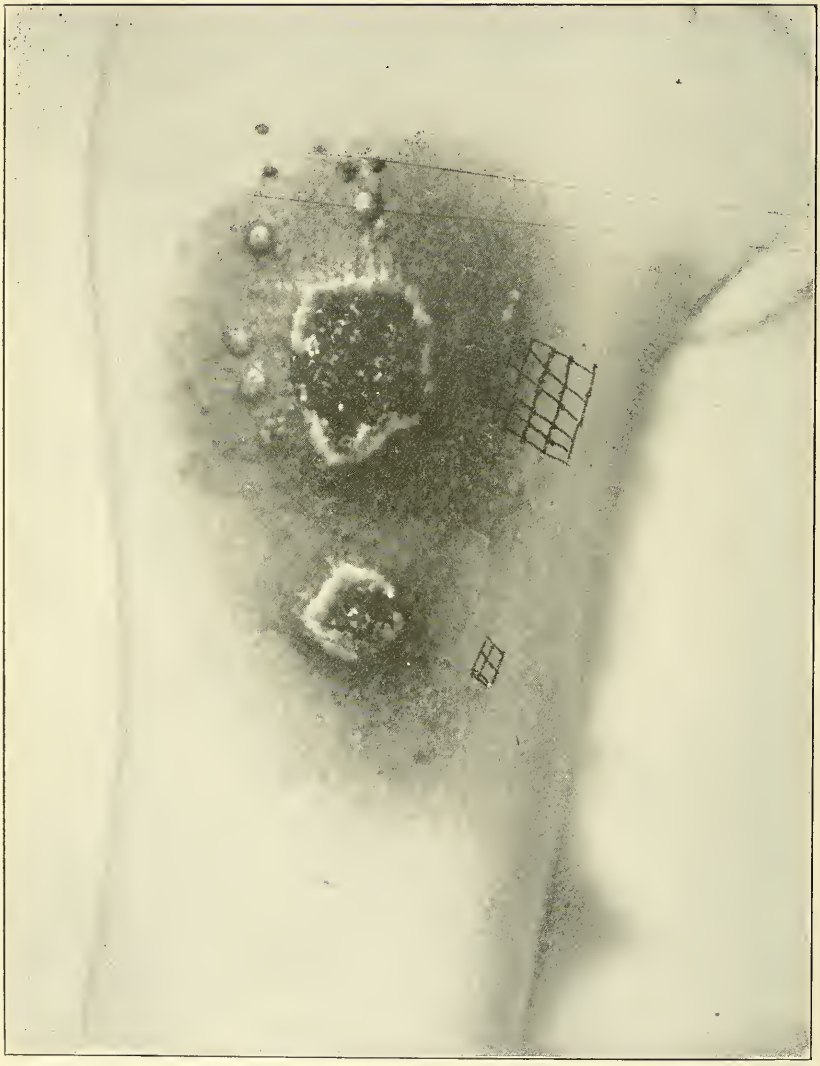
not be warranted in pronouncing such a patient unprotected; for it is certain that the areola and constitutional symptoms afford the only positive evidence of perfect protection.

Re-vaccination of all such cases readily proves that they are protected.

It appears, by the recent writings of some authors, that all these deviations must be due entirely to the character of the lymph introduced, but, the works of older vaccinators show that at no time in the history of the practice of vaccination has the surgeon escaped these occasional results. Such developments will occur as exceptions to the rule. Injury to the maturing pustule, personal idiosyncrasies of the patient, and, without doubt, the use of virus prolific in vaccine germs, applied over too extensive a surface, are among the common causes of degenerating vesicles.

Many cases of suppurating, slowly healing ulcers are due wholly to an injury to the vaccine vesicle in the course of its development. The removal, by accident or otherwise, of any portion of the capsule, or crust, allows the injured surface to become infected by the entrance of atmospheric germs.

Much has been said and written concerning a certain peculiar, eccentric action of animal lymph, described as "raspberry mark," or "excrescence," "red papule," "naneevus," etc. This is not a result known to modern vaccinators alone, nor existing only in cases where animal lymph has been used, as it was well known to the earlier vaccinators, and followed the use of humanized as well as bovine vaccine virus. It was often observed during the extensive vaccinations of 1872–3. It seems to be an



VACCINE VESICLES. Tenth Day.

Exact size of original scarifications shown, to illustrate that the extent of the scarified surface governs the size of vaccine vesicles. Both vesicles produced with the same lymph.

TYPICAL VACCINE VESICLES.
Tenth Day.

exuberant granulation of the nature of Keloid, stimulated, no doubt, by the application of serous fluid to the corium. It is needless to say that serum does not possess vaccine germs in an active condition, therefore, the results are irregular and unprotective.

That septic matter may obtain admission into vaccine lymph, prepared without aseptic precautions, is not questioned, but the cases of so-called septicæmia, which commence late in the course of the vaccine disease, and are sometimes reported as the result of septic matter existing in the lymph before it is introduced into the system, are from infected vesicles, acquiring the infection from atmospheric organisms, which have found their way into the pustule during its incubating period. In such cases, were the sepsis introduced with the lymph, septicæmia, with its usual train of symptoms, rigors, high temperature, gland infection, or erysipelas at the point of the local wound, would develop within a few hours.

A very rare, and, to the physician, interesting, case of eccentric action of animal vaccine virus occurred in a ward in Boston in 1882, and since no parallel case can be found in any ancient or modern writings on this subject, it seems to be of sufficient importance to merit description.

The following, from the pen of Dr. J. H. McCollom, appeared in the Boston Medical and Surgical Journal of October 12, 1882.

"The case about to be reported is entirely unique; the record of a similar one I have been unable to find anywhere. Mrs. B., a healthy woman, the mother of two children, was vaccinated February 13th, with bovine virus, by her family physician, Dr. Harris, of Roxbury, through whose kindness I saw the case, and to whom I am indebted

GENERAL VACCINIA.

Contracted through the medium of the mother's milk.

for the following notes. On the fifth day after vaccination the patient complained of headache, was feverish, and in fact had the usual amount of discomfort that attends a successful re-vaccination. Mrs. B. was at this time nursing her infant, a child about six months old. The child had not been vaccinated on account of eczema from which it was suffering at that time. On March 9th, as nearly as the mother can remember, an eruption appeared on the head, thorax, and the legs of the child, who had been feverish and irritable for two or three days previous. On some portions of the body the eruption was confluent, but on the arms and thighs it presented the characteristic appearance of cow-pox. It was not an instance of accidental inoculation, for there was no possible way by which the child could have introduced the virus at so many different points. The disease must have been contracted from the mother through the medium of her milk. The child was not very sick, although there was considerable discomfort from the eruption. The drawing gives a remarkably good idea of its appearance. In order to test the matter more thoroughly, Dr. Cutler, of Chelsea, charged a few points with the lymph, and inoculated a cow on the vulva. On March 15th, I received a note from him in which he says, 'I send you points taken to-day from a perfect vesicle planted upon the vulva of an animal seven days ago. The vesicle has an elevated base, a smooth, regular, perfectly spherical margin, is not yet umbilicated, and has all the characteristics of a pustule resulting from a series of human transmissions. This puts beyond cavil the question of identity in the Roxbury case.'" The final proof of the accuracy of the diagnosis, namely, vaccinating a human being with this virus, was not attempted.

COURSE TO BE TAKEN BY PHYSICIANS WHEN VARIOLA IS DISCOVERED.

The following extract from Seaton's Handbook of Vaccination treats the subject in a forcible and lucid manner.

"No question in medical practice may be regarded as more completely settled than the course which a practitioner should take when there are persons of any age whatever, unvaccinated or not otherwise protected against small-pox, in a house or family in which that disease breaks out. At once, and without any delay, the vaccination of all such persons should be performed; the loss of a day may be the sacrifice of a life. It does not follow that because a person has been exposed to the infection of small-pox that he has, therefore, received the infection, and the vaccination may be in time to prevent the disease altogether; but supposing that before the vaccination is performed, the variolous infection has actually been taken up by the system (of which, of course, during the stage of incubation we can know nothing), unless that infection have so far got the start that the small-pox symptoms appear before the vaccination reaches the stage of developed areola, the vaccine process will either prevent or modify the small-pox eruption; if, on the other hand, the variola manifests itself before the vaccination has reached its protective stage, its stage of areola, the vaccination, though it will have done no good, will most certainly have done no harm—the small-pox will simply go on as though it had never been performed. Now, whether the vaccination shall reach the stage of areola or not before the small-pox appears, depends entirely on the length of time which

had elapsed between the reception, by the system, of the variolous poison and the performance of the vaccination. As the incubative period of small-pox is twelve days, while the time requisite to bring vaccination to the stage of areola is only nine days, vaccination performed any time within the first three days will reach areola soon enough to produce its protective power; after this, whatever the local success of the vaccination, no constitutional protection will be imparted.

"If there were only any means of ascertaining whether a person exposed to small-pox infection had actually received it, and, if so, at what moment this had taken place, we should know exactly whether it were worth while to vaccinate or not; but as no such means exist, the obvious rule of practice is to assume that the poison has *not* been inhaled, or has only recently been inhaled, and to give our patient the chance. But no prudent practitioner, vaccinating under these circumstances, will commit himself as to the protective value of his vaccination until he has seen the areola completely formed.

"For want of knowledge or of consideration of these simple facts, practitioners have repeatedly compromised their credit, many lives have been lost that should have been saved, and erroneous entries are daily made in our death-registers. Seeing perfect vaccine vesicles on the eighth day, the practitioner who was not aware of the necessity of *waiting for areola* has promised safety, and been cruelly disappointed; his credit and the credit of vaccination have equally suffered. The occurrence of three or four cases together of unmodified, and perhaps fatal, small-pox in persons having well-formed and complete vaccine vesicles on their arms, has at times led the

practitioner, not to the true explanation, *viz.*, that his vaccination in these cases has been too late, but to the notion that vaccination was always useless when small-pox was incubating, and even to the absurd and totally unfounded supposition that it might increase the danger; so he has shut up his vaccine lancet, and children have been allowed to perish from non-performance of vaccination, whose deaths were clearly chargeable to his error. Our death-registers contain innumerable entries of deaths from 'small-pox after vaccination,' which were simply cases of death from small-pox in children in whom vaccination was performed during the incubation of small-pox; and heaps of published and other records are quite unusable for any statistical purposes, because cases of this kind are not distinguished from the cases in which small-pox really did occur in persons who had properly received the constitutional infection of vaccination.

"The practice, which I have known at times adopted, of vaccinating a person after symptoms of small-pox have actually manifested themselves, is utterly absurd; so far as the patient is concerned, the effect, of course, is *nil*; but on account of the discredit it tends to bring upon vaccination with the public, it is a practice which should be strongly discountenanced."

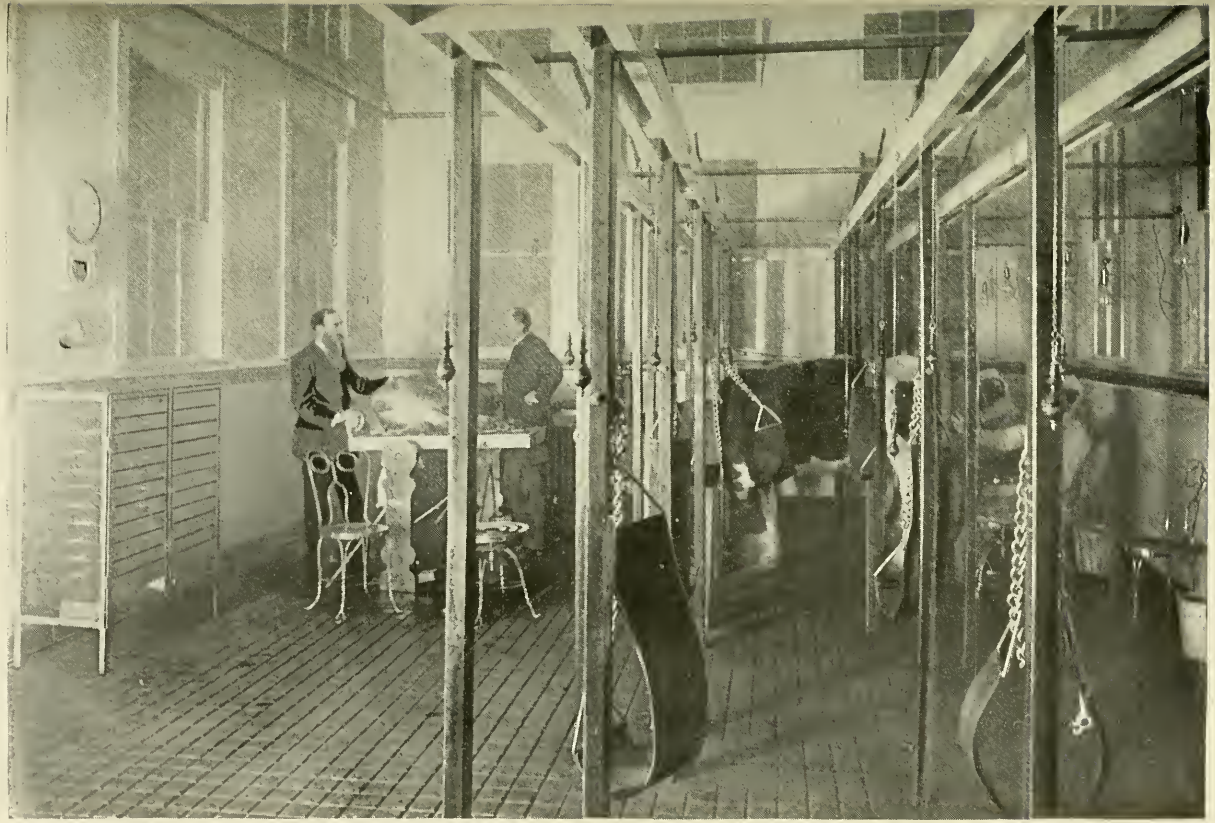
CULTIVATION OF VACCINE VIRUS.

Animal vaccination has been successfully practised in the United States for more than twenty years, and experience has proved it to be the only method by which a large supply of vaccine lymph, equal to the demands of a general epidemic of small-pox, can be furnished. During this

period, nearly all the methods of vaccinating animals, and collecting and storing vaccine lymph, now practised in the older countries, have been thoroughly tested, and finally abandoned in this country, until now the pure lymph taken from thoroughly cleansed, open vesicles, and stored by drying upon ivory points, is admitted to be the safest, most reliable and convenient form.

The technique of bovine vaccination by different operators varies to such an extent, in so many essential features, that space will not admit of descriptions in detail. There is a wide difference of opinions as to the age of animals best adapted for the cultivation of vaccine lymph, some propagators choosing nursing calves, others yearlings, and many, mature young heifers, preferably from two to four years old. Ideas also vary as to the proper period for opening the vaccine vesicles. It is certain, however, that, in most cases, the pustules yield a much larger quantity of lymph after one hundred and sixty-eight hours of incubation than when opened earlier in the course of development. It may be claimed, perhaps with some degree of reason, that lymph taken twenty-four hours earlier will give better results and a much larger percentage of successful vaccinations, in which case one hundred and forty-four hours should constitute the incubating period.

An operating room for the propagation of vaccine virus should be arranged, as far as possible, with a view to complete asepsis. The same may be said of the stables in which the animals are kept during the incubating period. All floors, ceilings and walls should be made of non-absorptive materials, so constructed as to admit thorough flushings of boiling water and antiseptic solutions. All forms of



Operating Room. New England Vaccine Company.

bedding for the animals should be regarded as vehicles for the lodgement and cultivation of microbes.

Asepsis in the cultivation of vaccine lymph must be applied to the surroundings of the animals during the incubating stage of the pustules and in the operating rooms, where the lymph is extracted from the vesicles and stored. The product of the vesicles, after it is taken from the animals, if not aseptic, cannot be sterilized nor purified by any antiseptic agent, without destroying also the life of the active principal of the lymph. All forms of vaccine virus, except the pure exuding lymph, should be classed as possibly infected matter, having remained on the animal for a full week, meanwhile accumulating dust from the stable and atmospheric germs. Dried lymph in the form of crust has generally passed out of use in this country. The quantity of this crust which exists on vaccinated animals is very tempting to propagators. It enters very largely into the glycerine pastes and vaccinating fluids stored in glass tubes, and issued in France, Italy and Germany under the name of aseptic, sterilized vaccine virus. The operators lay great stress upon the sterilization of all vehicles in which the lymph is stored, but the fact remains that this product is that portion of the vesicle, formed from the debris of broken-down tissue, cell detritus and an admixture of pus, which has not been and cannot be sterilized.

METHODS OF VACCINATING.

Cleanliness of the cutaneous surface upon which the vaccine virus is applied and of the instruments employed in making the necessary scarifications is of the utmost importance.

Section of Stable. New England Vaccine Company.

The vaccinator should always avoid all forms of vaccinating instruments, or any instrument which is designed for successive cases. A common sewing needle is a convenient scarifier used by many operators, one for each subject. When once used, it is thrown aside, and a new one applied to the next in order. Physicians who use lymph stored upon ivory lancet points will find nothing so clean and convenient for the purpose of scarifying as the ivory point, and it has the advantage of always being at hand. It should not be applied to more than one person.

The scarification should be on the left arm at a point near the insertion of the deltoid muscle, and should be just deep enough to bring into view the fine net-work of capillary vessels. A little bleeding is of no consequence, an excess should be avoided.

The too common practice of vaccinating the lower limbs should be avoided. Vaccinations upon the leg below the knee have often produced serious results. The constant movement of the muscles in locomotion and the irritation from the clothing serve to inflame the maturing vesicle. The œdema which often attends a vaccination on the leg obstructs the venous circulation and favors slow healing and indolent ulceration, especially if the subject has passed middle life. In such cases, similar unfavorable results may follow simple abrasions of the skin or any slight injury.

Many vaccinators cover the scarification and its applied lymph with surgeon's plaster, but this should not be countenanced, as it confines the secretions and favors septic formations.

All careful physicians require their vaccinated patients to return for inspection and advice on the fifth or sixth

Office. New England Vaccine Company.

day. Dressings, like poultices, oil, tallow, vaseline, or water, tending to soften the capsule of the pustule, should never be applied to an unbroken vesicle. Every application or treatment which may deprive the vesicle of its natural protection, the scab, serves only to prolong the healing processes and furnishes a free entrance to microörganisms. If, by accident or suppuration, the crust or capsule has been sacrificed, then the surgeon is warranted in the use of any remedy which his judgment dictates.

AGE FOR VACCINATING.

The vaccine disease is well borne by very young infants prior to dentition. The preferable age is from one to two months.

This age was usually selected by the older vaccinators, for the reason that the vaccine disease appears more violent in proportion to the increased age of the child.

Physicians would follow the right course now, should they vaccinate all infants before making their last visits to convalescent mothers.

There is a growing tendency, on the part of physicians as well as of parents, to neglect vaccination until compelled by school regulations.

RE-VACCINATION.

The best authorities advise re-vaccinating at puberty.

On the approach of an epidemic, or whenever a case of small-pox is discovered, re-vaccination becomes imperative in that locality.

Office. New England Vaccine Company.

Physicians, as a class, are notably exempt from small-pox, although very often exposed. It is their custom to re-vaccinate themselves whenever a case of variola appears in their vicinity. Should this be practised by all persons, an epidemic of small-pox would be unknown.

COMPULSORY VACCINATION.

To a superficial investigator, compulsory vaccination may appear to be an infringement upon the personal rights of an individual, but when his relations to society are such that he becomes dangerous to the life and health of others, he should then be considered a nuisance, and legally treated as such. A law which compels vaccination reaches beyond the personal question, and affects the interests of the community, for every unvaccinated person contributes to the material that increases great epidemics. No city with a large unvaccinated population is ever safe from the ravages of small-pox.

Dr. Carpenter, whose efforts in behalf of the hygienic good of man have been both earnest and successful, was a zealous advocate of compulsory vaccination. He maintained that it is the right and the duty of the State to act for the good of the public in matters of health as well as of education; that society should be protected against disease and death as well as against illiteracy.

The efficacy of vaccination as a preventive of small-pox is doubted by no unprejudiced person. Small-pox will never be blotted out of the list of existing diseases until the practice of vaccination and re-vaccination is extended and enforced.

Caricature, by Gillray, published in 1802.

The common people, encouraged by the Anti-Vaccinationists, believed that these results would inevitably follow the general introduction of vaccination.

INDEX TO ILLUSTRATIONS.

Bust of Edward Jenner, frontispiece.
Varicella, third day, ... 12
Variola, third day, ... 13
" fourth day, ... 15
" fifth day, ... 17
" sixth day, ... 19
" seventh day, ... 21
" eighth day, ... 23
" tenth day, ... 25
" eleventh day, ... 26
" " " actual size, ... 27
Vaccine Roseola, ... 36
" Erythema, ... 37
" Vesicles, tenth day, ... 40
" " Typical, ... 41
General Vaccinia, ... 43
Operating Room, ... 49
Section of Stable, ... 51
Office Interior, ... 53
" " 55
Caricature by Gillray 57

INDEX.

History of Variola, ... 3
Inoculated Variola, ... 9
Measles, ... 10
Variola and Varicella. Comparative Description, . . 11
Vaccinia, ... 28
Growth of the Vaccine Vesicle, ... 33
Vaccine Roseola, ... 36
Vaccine Erythema, ... 37
Course to be taken when Variola is Discovered, . . 45
Cultivation of Vaccine Virus, ... 47
Methods of Vaccinating, ... 50
Age for Vaccinating, ... 54
Re-Vaccination, ... 54
Compulsory Vaccination, ... 56

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